DEMILITARIZATION OF WHITE PHOSPHORUS MUNITIONS

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ABSTRACT

This paper highlights one of the first resource recovery projects undertaken by the U.S. Army to meet the intent of the Resource Conservation and Recovery Act, which was the development and successful operation of a White Phosphorus to Phosphoric Acid Conversion Plant for disposal of white phosphorus filled munitions. Background for the plant development is presented, along with an operational history of the plant, and a description of the plant and how it operates.

INTRODUCTION

In August 1980, a moratorium on open burning of smoke munitions was issued by the Office of the Surgeon General of the Army, leaving the Army, as the single manager for conventional ammunition, the difficult problem of developing environmentally safe procedures for demilitarizing chemical smoke munitions.

BACKGROUND

Tests conducted by the Ammunition Equipment Directorate (AED), Tooele Army Depot, Tooele, Utah, showed that white phosphorus (WP) filled munitions could be burned in the Ammunition Peculiar Equipment (APE) 1236 Deactivation Furnace if the explosive components were removed and a hole was punched in the sidewall of the munitions. Since phosphoric acid is manufactured commercially by burning WP and scrubbing the resulting phosphorus pentoxide, AED engineers proposed adding a scrubbing system onto the furnace to produce acid from the burning of WP filled munitions. It was also proposed to make the scrubbing system mobile so that it could be transported to installations storing significant quantities of WP filled munitions and installed on their existing deactivation furnaces.

PROJECT ESTABLISHMENT

The Defense Ammunition Directorate, U.S. Armament, Munitions, and Chemical Command (AMCCOM), Rock Island, Illinois, evaluated the AED proposal against a proposal to recover WP from WP filled

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munitions, and determined that in either case, an incineration plant would be needed to decontaminate the emptied metal grenade and projectile bodies, and to dispose of WP contaminated water resulting from WP recovery operations. As a result AMCCOM funded AED in 1981 to develop a pilot process plant to incinerate white phosphorus (WP) filled munitions and convert the resulting phosphorus pentoxide to a saleable phosphoric acid. This project represented one of the first projects in the U.S. Army that was responsive to the constraints and intent of the Environmental Protection Agency (EPA) and the Resource Conservation and Recovery Act (RCRA). The resulting process involved the marriage of industrial acid conversion technology and processes to modified APE, and provided the capability of handling the wide variety of WP filled munitions, from grenades to 155 mm projectiles.

The original intent was to develop a White Phosphorus to Phosphoric Acid Conversion (WP/PAC) Plant that would be portable and could be transported to five locations where the majority of the WP munitions were stored. The five locations were: Ft. Wingate Depot Activity, Gallup, New Mexico; McAlester Army Ammunition Plant, McAlester, Oklahoma; Crane Army Ammunition Activity, Crane, Indiana; Letterkenny Army Depot, Chambersburg, Pennsylvania; and Hawthorne Army Ammunition Plant, Hawthorne, Nevada.

PILOT MODEL PLANT AT FWDA

The pilot model WP/PAC plant was assembled and tested at Ft. Wingate Depot Activity (FWDA). By early 1984, the plant had successfully processed 2,342 short tons of WP filled munitions, producing over 2.2 million pounds of 75% phosphoric acid and 1.9 million pounds of scrap steel from the munitions, both of which were sold on the open market.

PRODUCTION PLANT AT CAAA

Crane Army Ammunition Activity (CAAA), with the next largest inventory of WP munitions, and with its ammunition processing capabilities and expertise, was selected to be the next site for the WP/PAC Plant. Based on the operational experience gained at Ft. Wingate, it was determined that several upgrades to the system would be required to improve the operation of the system, increase the system availability and efficiency, and more fully automate the plant operational controls. All of this made the idea of portability less practical. Subsequently, the decision was made to locate the WP/PAC permanently at Crane AAA, and ship all WP munitions there to be processed for disposal. Upon completion of processing all WP assets at FWDA, the plant was decontaminated, disassembled, and moved to Crane AAA, where, through the efforts of AMCCOM headquarters, TEAD, and CAAA personnel, the plant was reassembled, and substantial modifications and improvements were made to the pilot plant equipment used at FWDA.

DESCRIPTION OF WP/PAC PLANT SYSTEM AND OPERATION

The WP/PAC Plant is designed to operate 24 hours a day, seven days a week. The operations to demilitarize WP munitions involve initial downloading of explosive components, such as fuzes, bursters, and propelling charges, from the munitions. The WP filled munitions, now without any explosive or propellant components, are delivered to the WP/PAC Plant where they are fed into a hydraulic press which punches a hole into the side wall of the munitions exposing the WP filler. The size of the hole to be punched and the frequency at which munitions are fed into the furnace are adjusted to establish a feed rate of WP into the furnace of approximately eight pounds per minute. After punching, the munitions are pushed into the feed chute of a modified APE 1236 Deactivation Furnace where they are gravity fed into the rotary kiln. In the kiln, the heat from the furnace burner and burning WP melts and then vaporizes the WP inside the munitions. As the WP vapors expand, they exit the munitions through the punched hole where they burn or oxidize to form phosphorus pentoxide.

The negative pressure, maintained in the entire system by two 75 horsepower draft fans mounted in series at the end of the system, draws the phosphorus pentoxide through a cocurrent/ countercurrent flow hydrator where approximately 70% of the phosphorus pentoxide is removed from the gas stream by concentrated acid sprayed into the hydrator. The concentrated acid flows by gravity to a collection tank. Concentrated acid from the collection tank is cooled and recycled to the hydrator. As the concentration of the acid reaches the preset concentration of phosphoric acid (75%), a side stream of acid is diverted to the acid storage tank.

The remaining gas stream passes through a variable throat venturi where a pressure drop of 70 inches wc is maintained across the venturi. Two spray nozzles located at the venturi inlet provide dilute acid for the separator scrubbing process. From the venturi, the gas stream enters the separator tangentially at the bottom and exits out the top. Two mist eliminator pads are sequentially located in the top of the separator and are wetted by sprays of dilute acid. The dilute acid is collected in and recycled to the demister pads from a dilute acid tank. The gas stream then passes from the separator through two 75 horsepower draft fans mentioned above and through a final demister vessel containing two Brinks mist eliminator 'candles' in series downstream from the blowers. The demisters remove aerosol particles from the gas stream prior to exiting the stack. The demisters operate at a 99.9% plus efficiency.

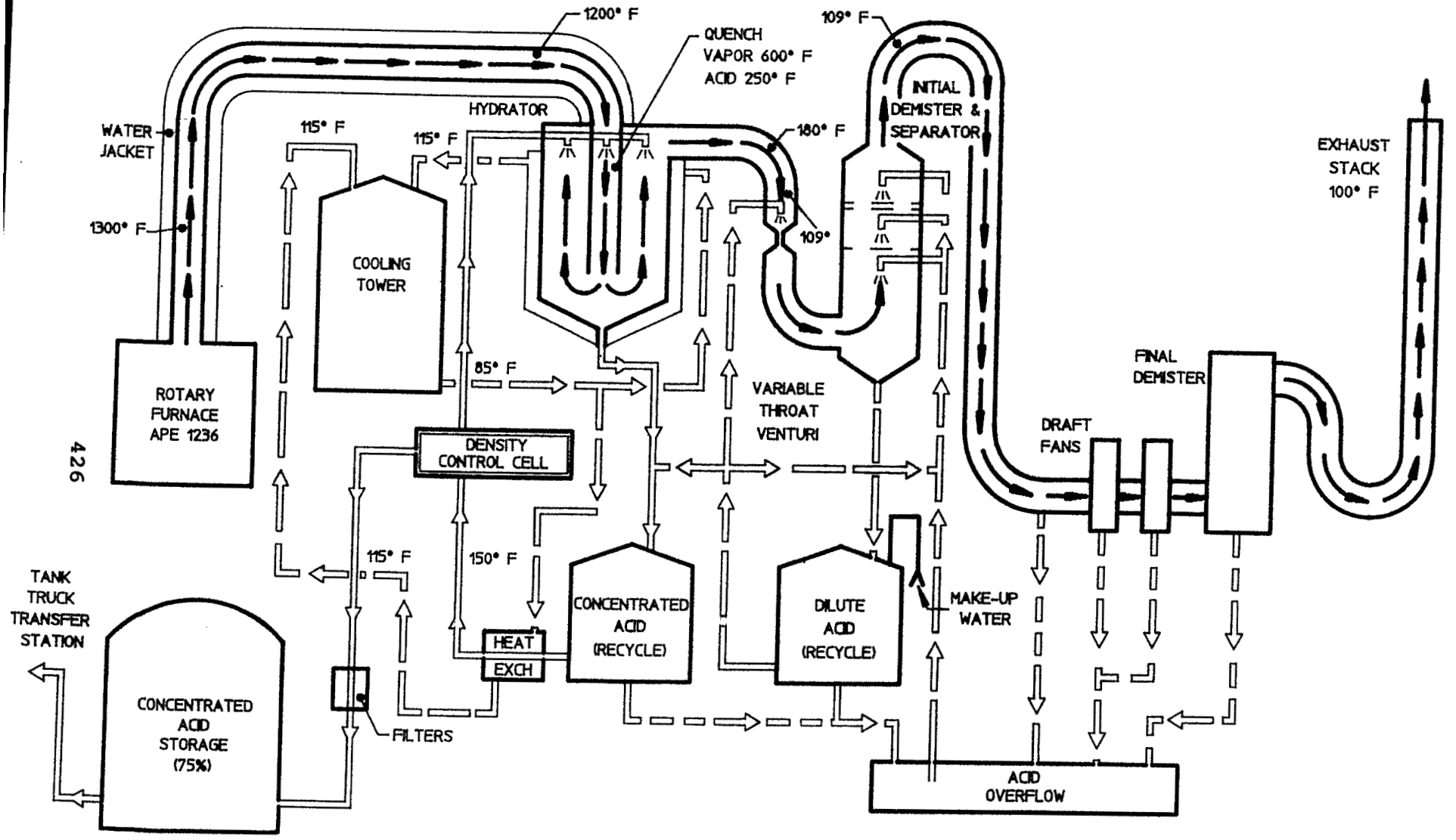
All plant functions are continually monitored, recorded, and controlled from a central location by two Allen-Bradley automated controllers. The product acid is filtered for removal of suspended solids above one micron in size, and is then stored on site waiting transfer to a tanker truck. The storage capacity at the site is 16,300 gallons (108 tons). Revenue from the acid sales to private industry are returned to AMCCOM headquarters, as is the revenue from the brass rotating bands, expended steel munitions bodies, and empty wooden boxes.

SUMMARY OF THE WP/PAC PLANT OPERATIONS

Since the plant officially began full scale operations at CAAA on 6 February 1989, acid sales have returned in excess of $1 million to AMCCOM. Over $300,000 has also been returned on the sale of more than 10 million pounds of scrap metal. As of August 1990, 199,159 3.5" rocket warheads, 198,101 4.2" mortars, 494,480 90 mm projectiles and 60,000 105 mm projectiles have been processed, which represents 2,992,000 lbs of WP. The plant operational availability, originally estimated at 85%, consistently operates in excess of 90% as a result of the modifications made to the original pilot plant equipment and controls.

The WP/PAC plant has the capability to process up to 11,520 pounds of WP daily thereby producing over 48,000 pounds of 75% concentration phosphoric acid in a 24 hour period. By the end of the program, almost 5 million pounds of WP will be processed and over 20 million pounds of phosphoric acid will have been produced and sold on contract. This represents the demilitarization of approximately 20,000 short tons of WP munitions.

Because of the heightened awareness of environmental issues nationwide, and the increased technology utilized in development of new ammunition items, the Department of Defense (DoD) services will need to continue to develop demilitarization processes of this nature. The WP/PAC plant represents a unique blend of state-of-the-art and state-of-the-industry technology, and existing demilitarization methods, while maintaining the highest environmental quality.



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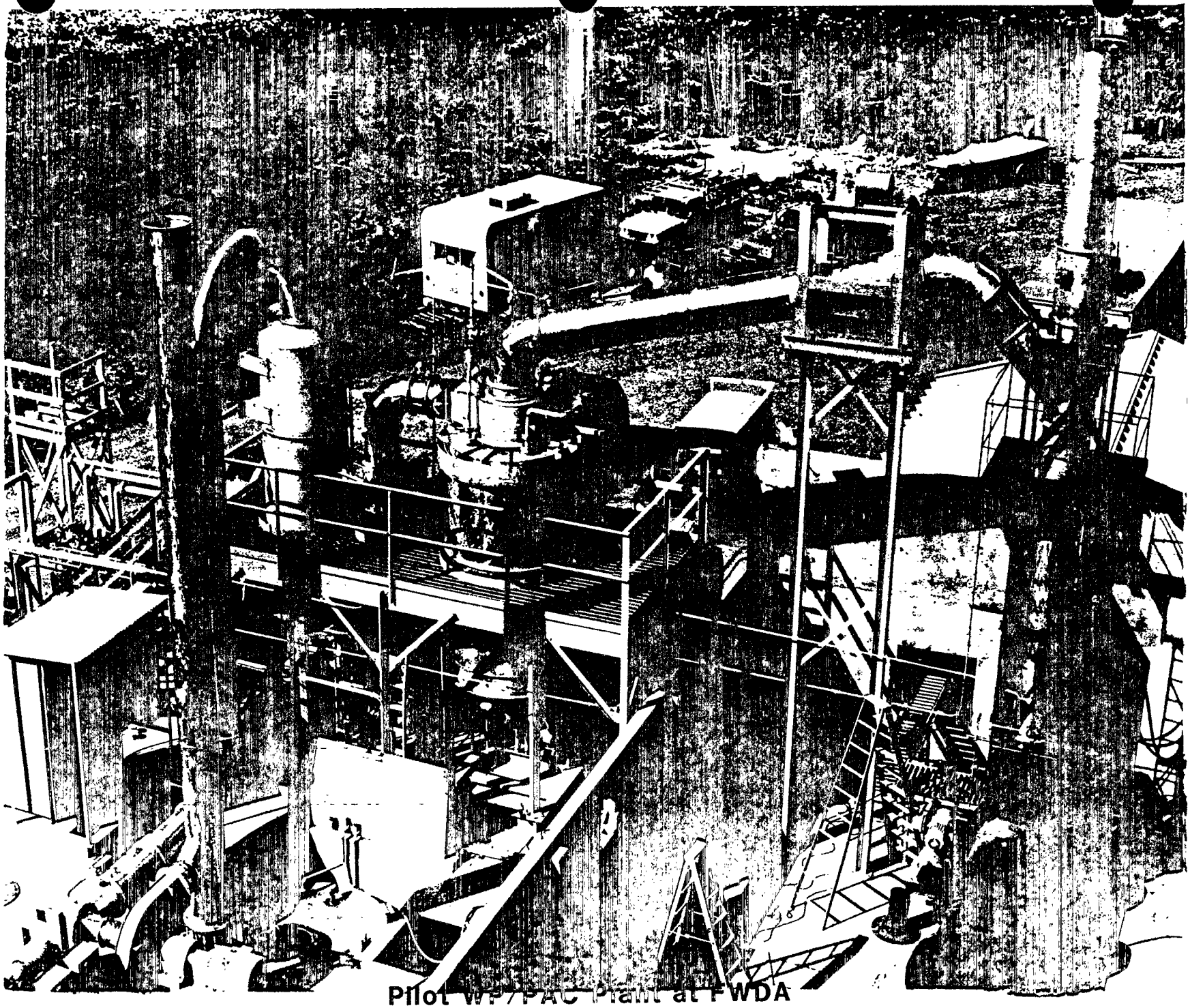
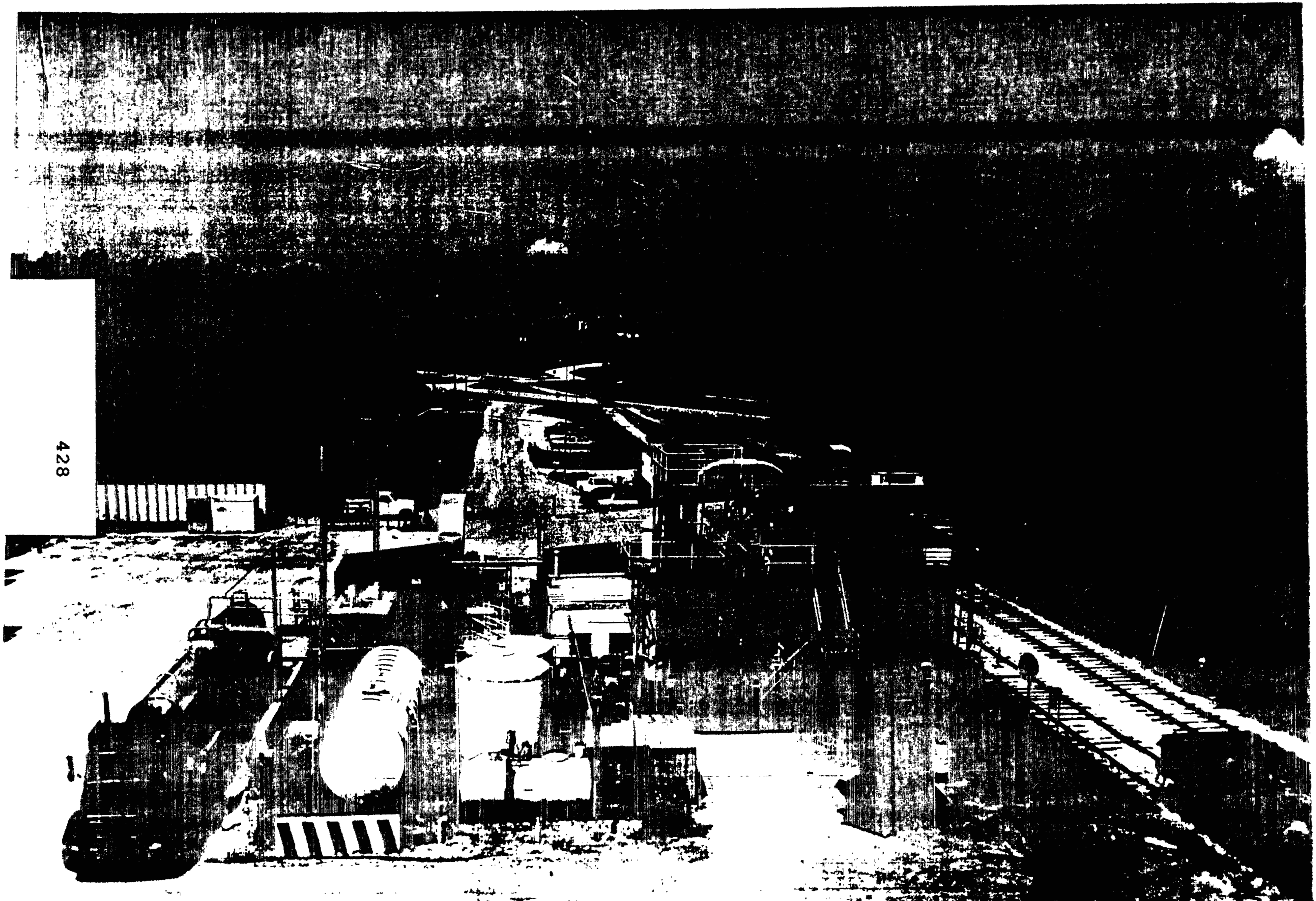
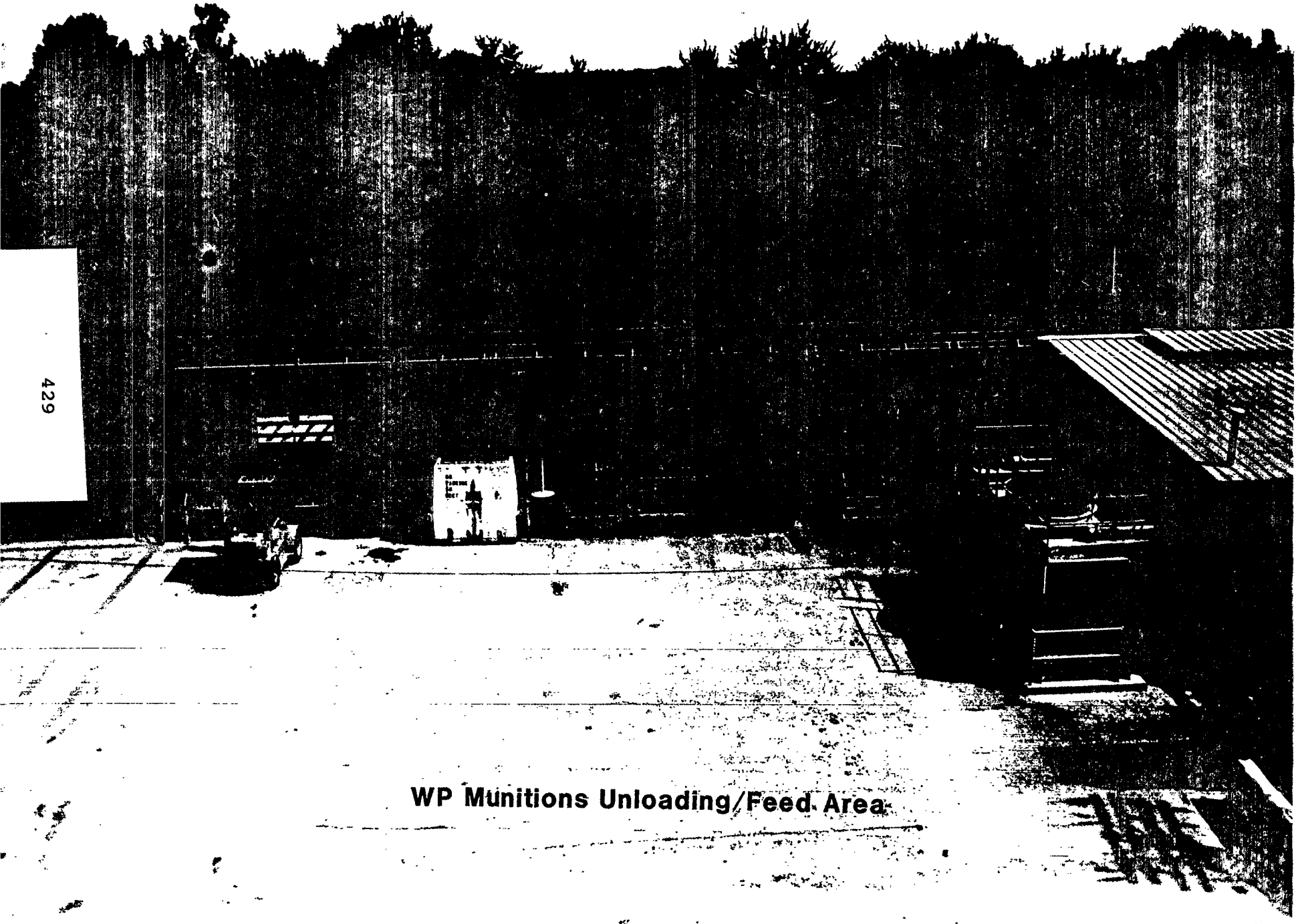
SIMPLIFIED WP TO PHOSPHORIC ACID CONVERSION PLANT
FLOW DIAGRAM



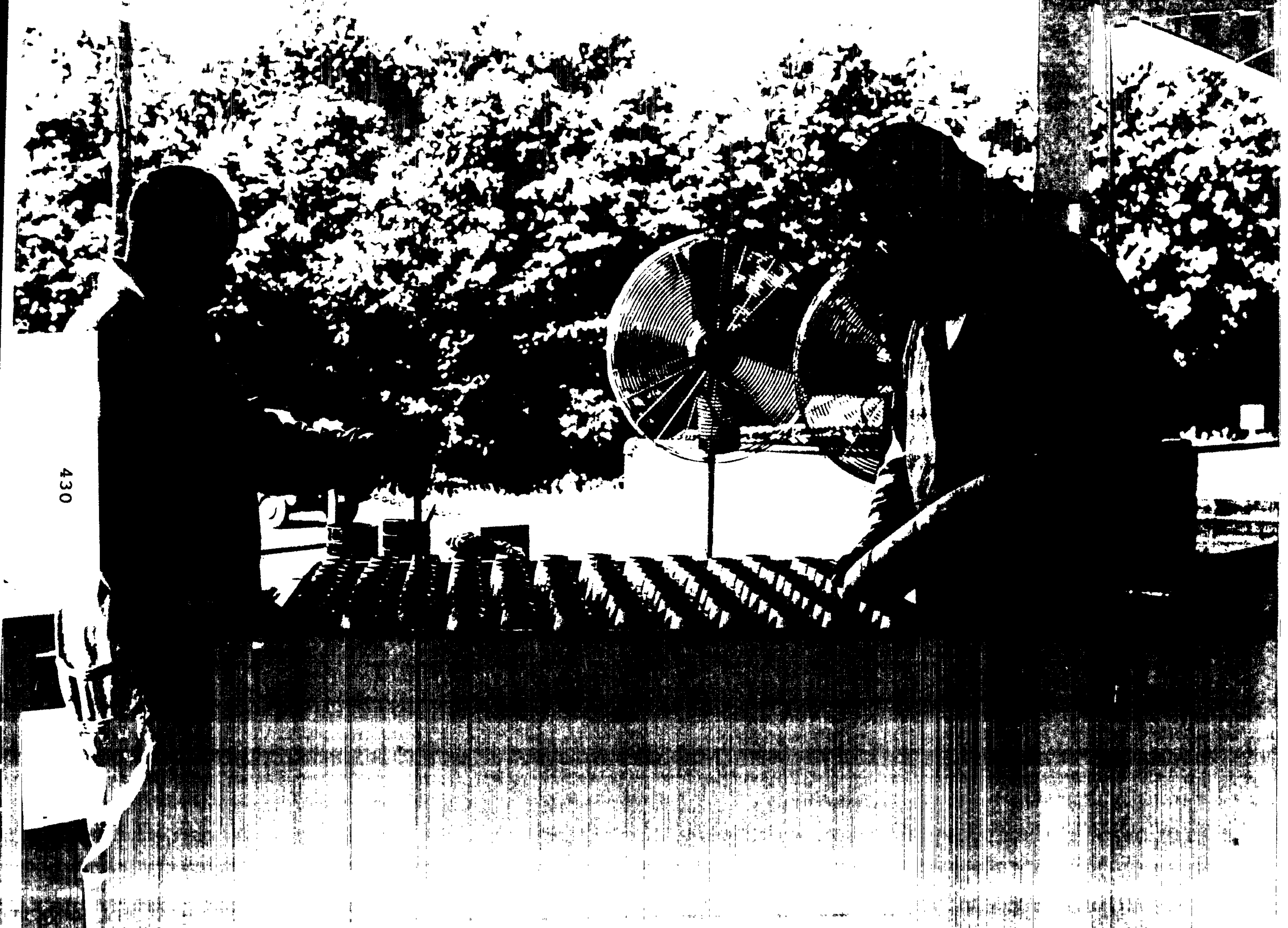
Pilot WP/PAC Plant at FWDA



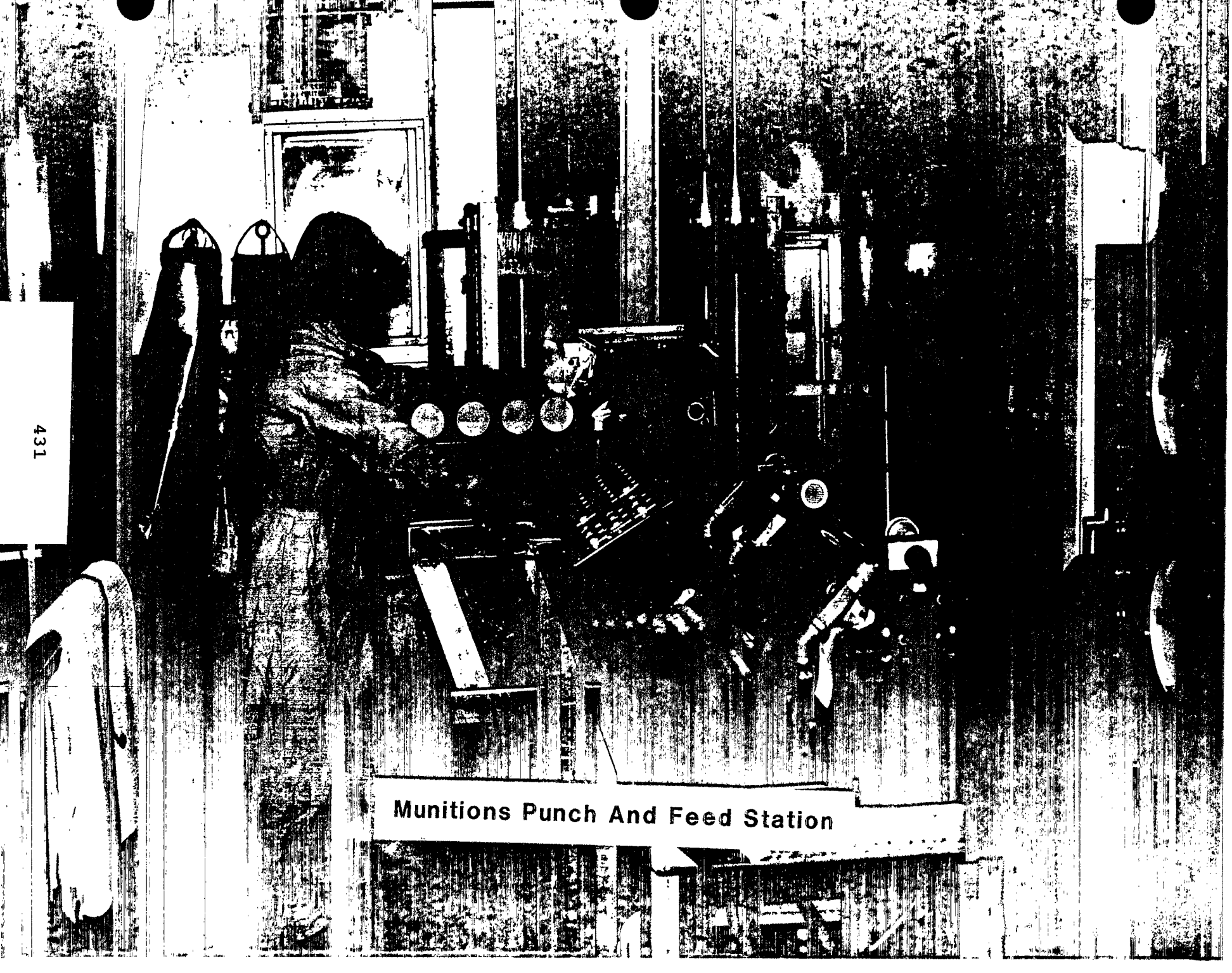
Overall View of WP/PAC Plant at Crane AAP



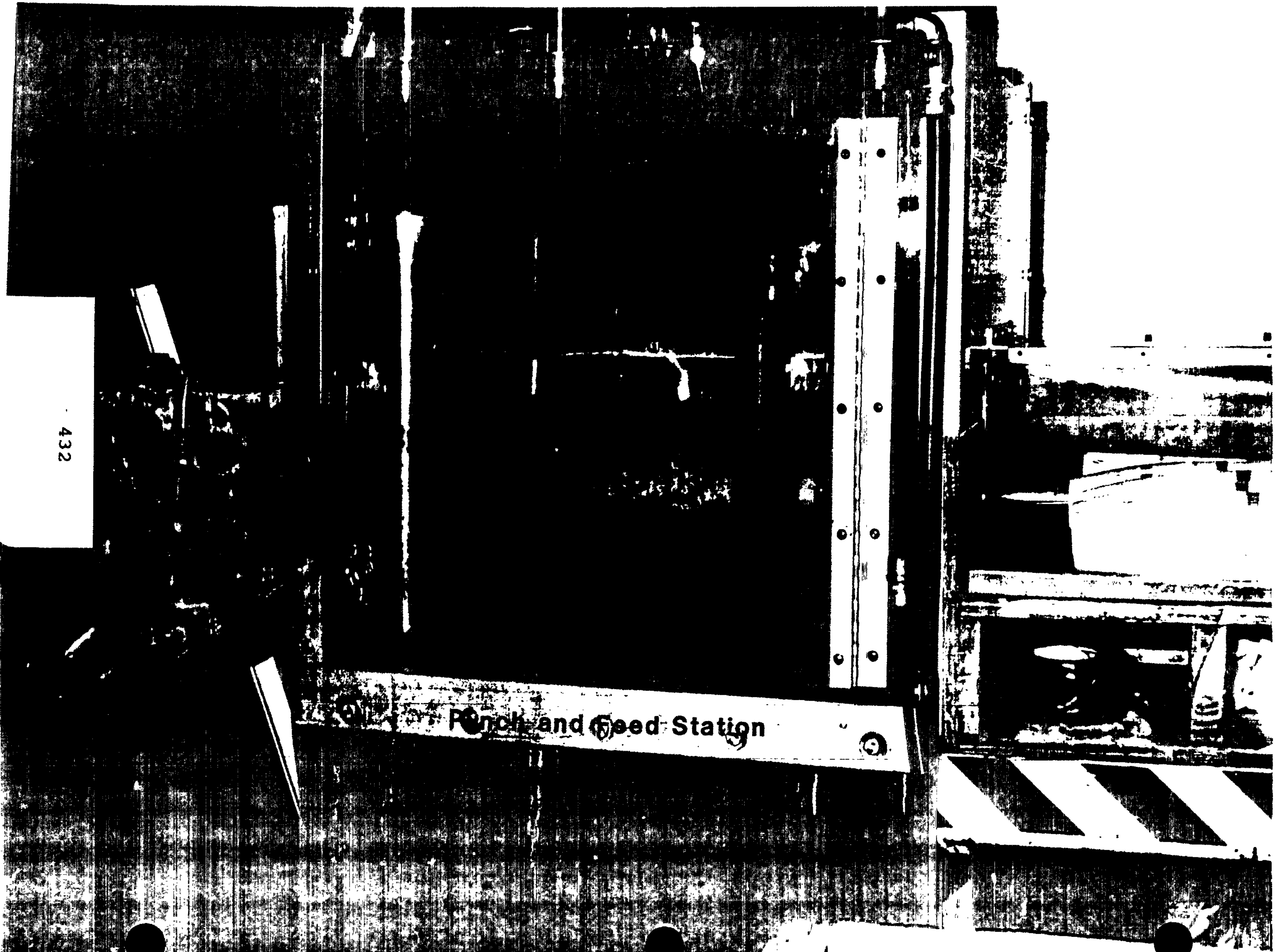
WP Munitions Unloading/Feed Area

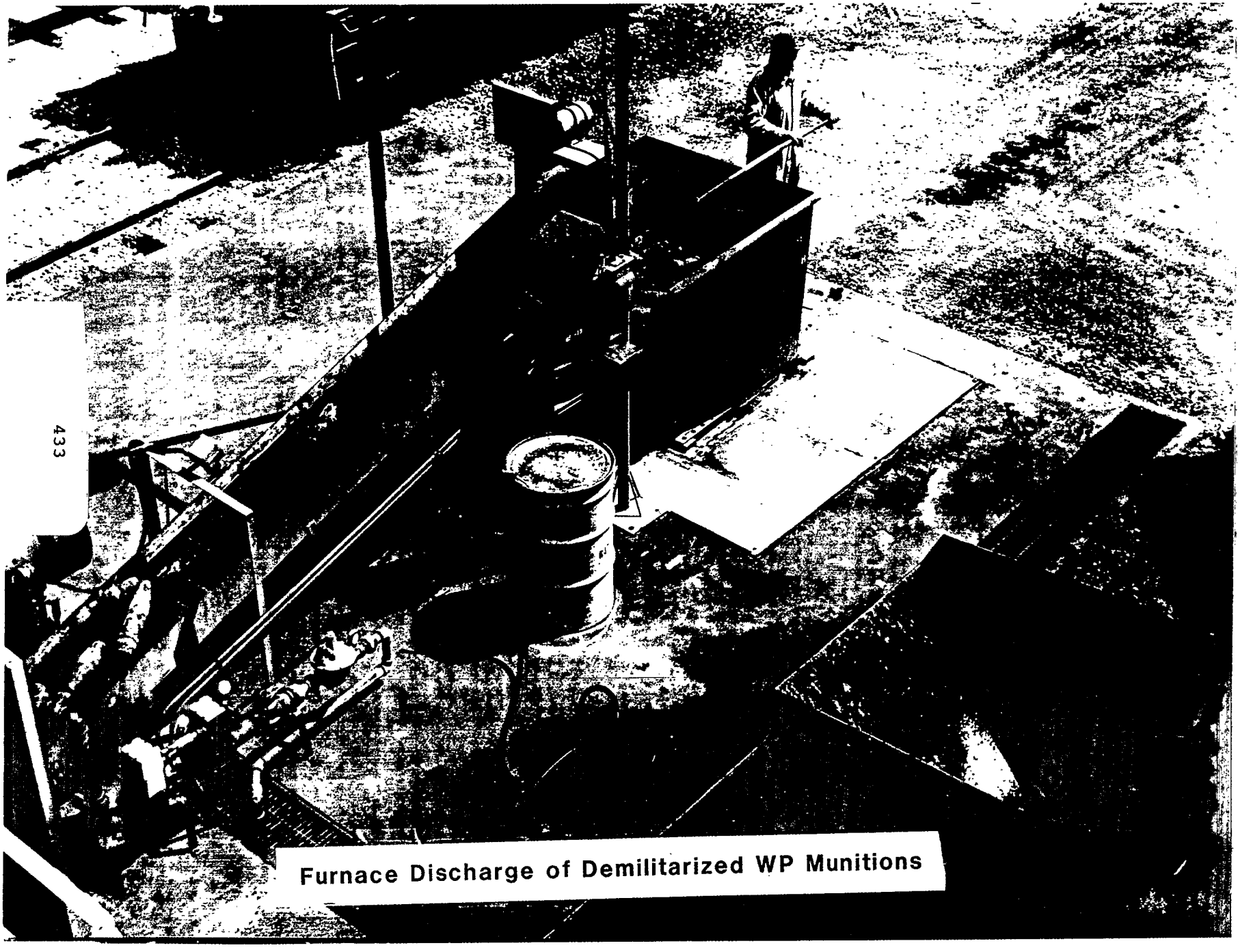


Checking For Burstals In WP Munitions

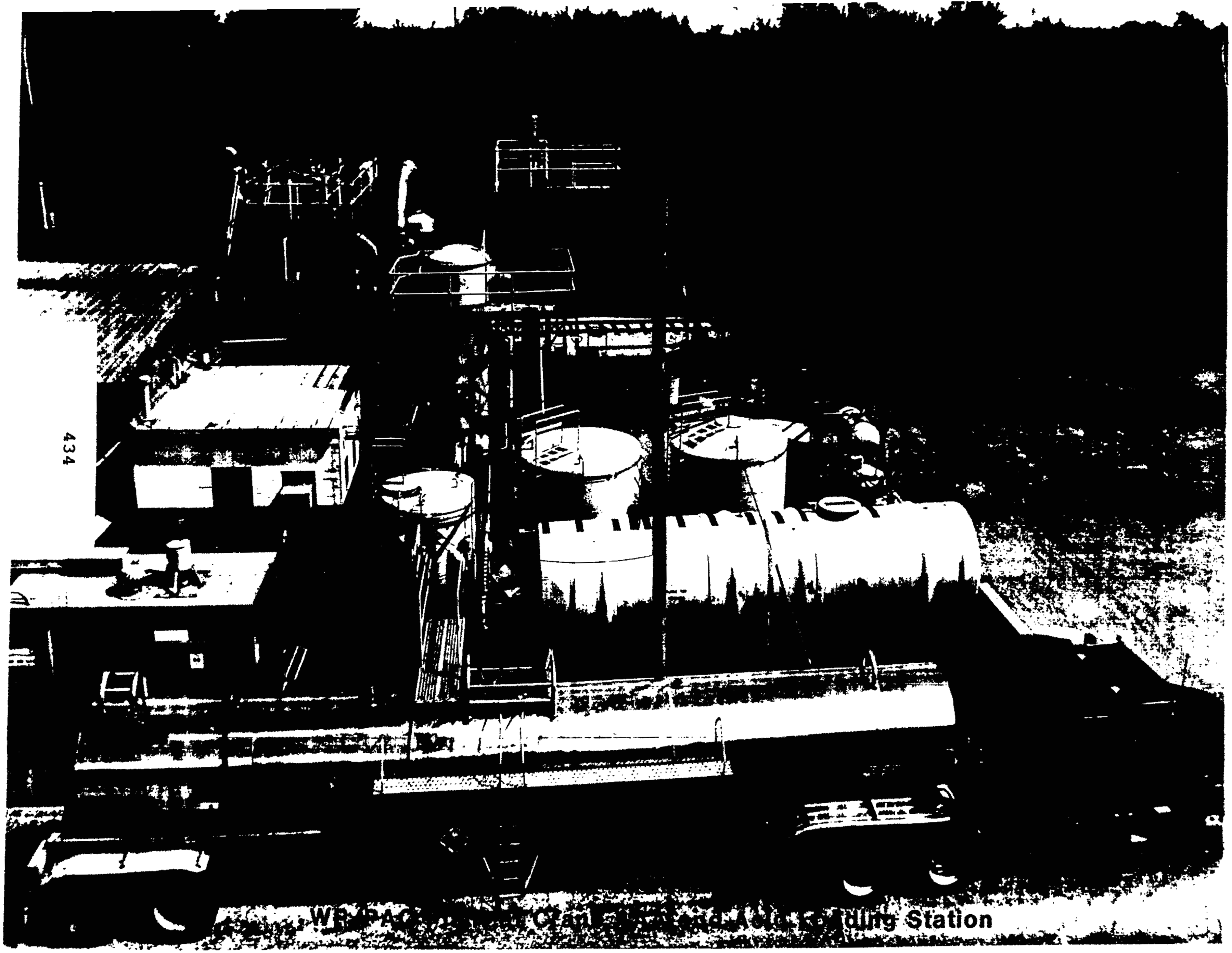


Munitions Punch And Feed Station

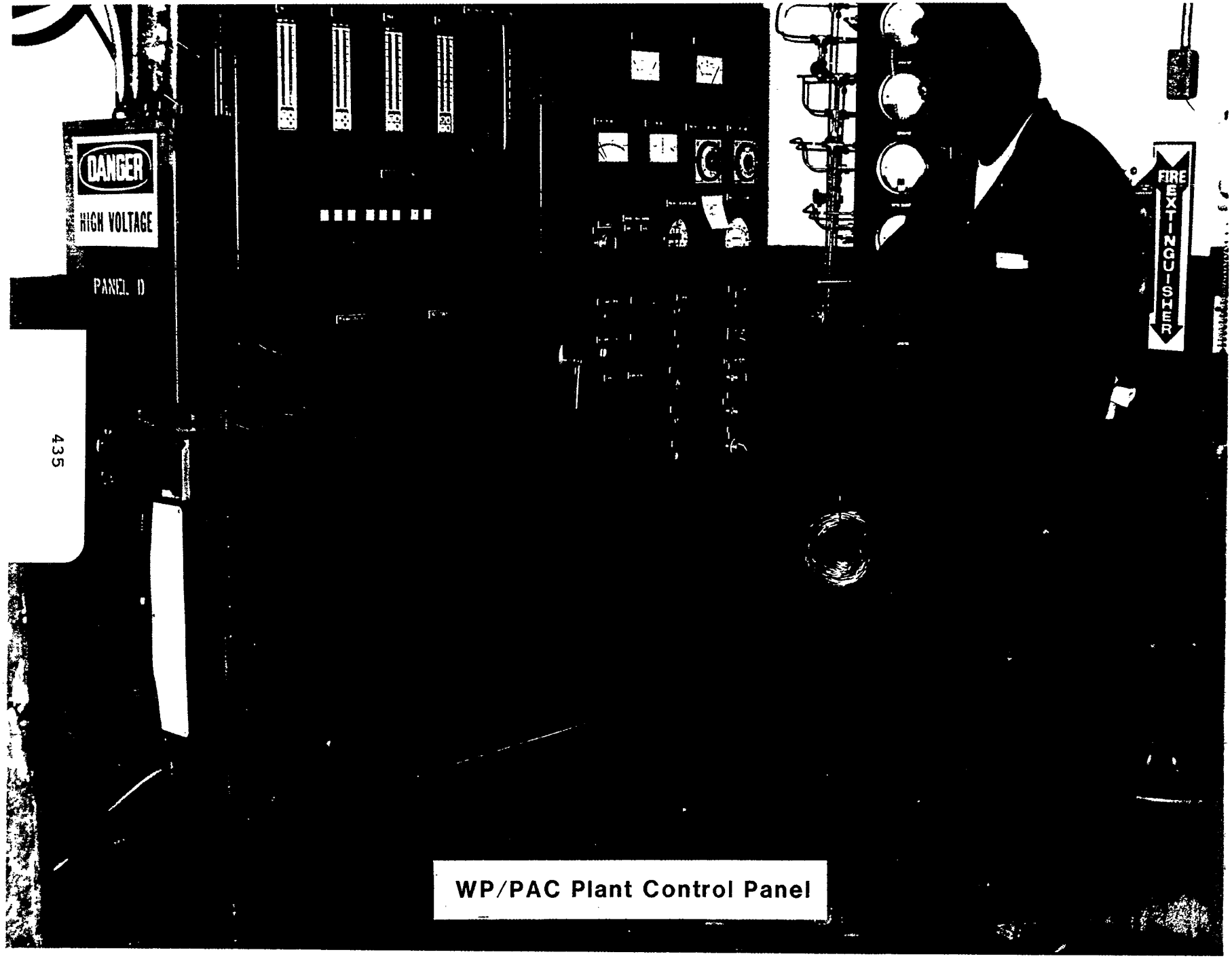

Punch and Feed Station



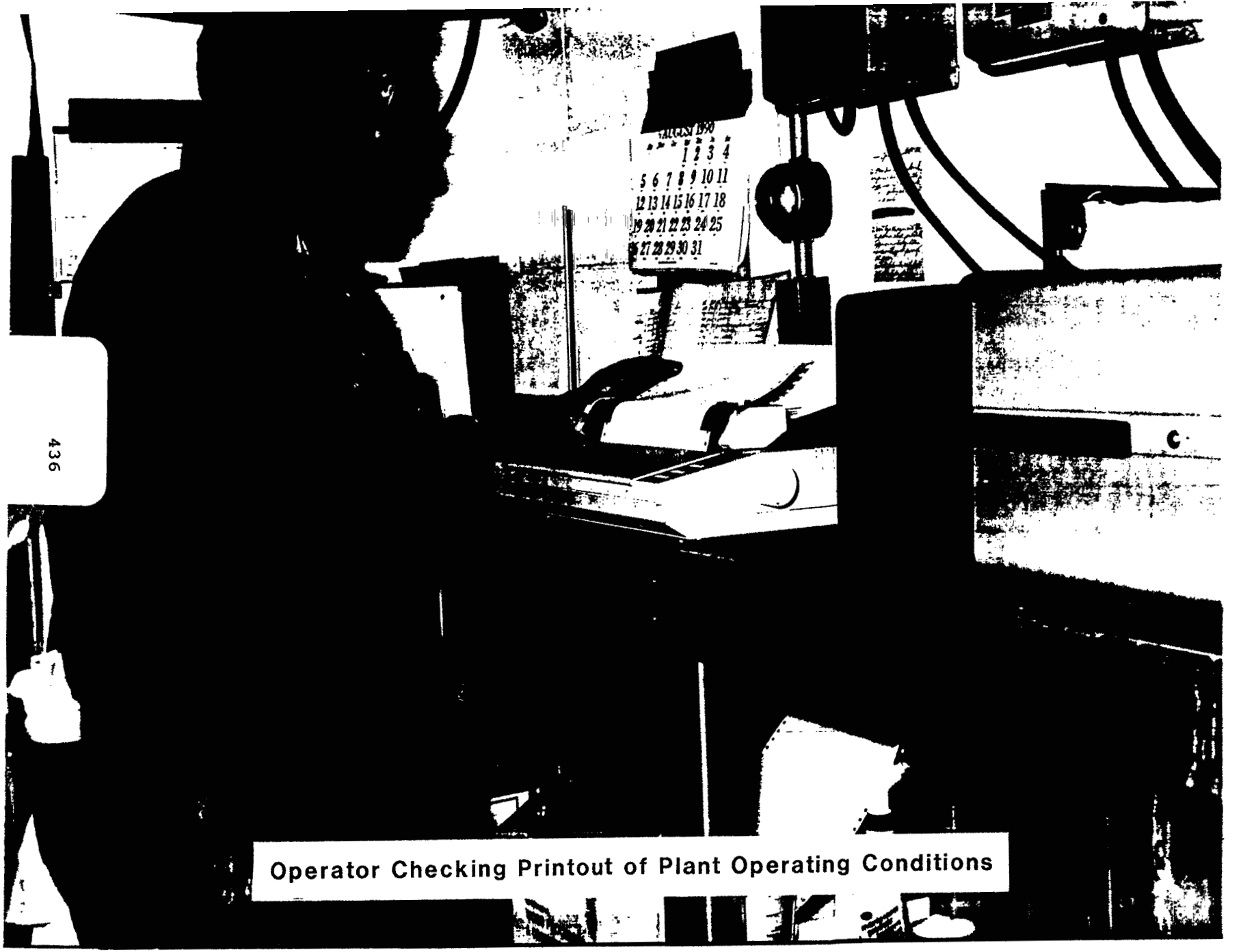
Furnace Discharge of Demilitarized WP Munitions



WR[illegible]PAC [illegible] Plant [illegible] Acid [illegible]ding Station



WP/PAC Plant Control Panel



Operator Checking Printout of Plant Operating Conditions

WP/PAC Plant Operator Changing Acid Filter Bag